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Helping Struggling Readers Build Math Understanding through Word Problems

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Introduction

Why do we love to watch movies? What is the purpose of the motion picture industry? Aside from monetary benefits, a movie—at its core—is storytelling. It is a medium in which an artist (e.g. Director, Writer, Producer, Actor) is able to "paint their picture"—expressing themselves. That (motion) picture can be used to educate and entertain. Action, Adventure, Horror, Thriller, Sci-Fi, Documentary, Drama, Comedy, and Mystery are a few of the many genres in the motion picture industry. There is no doubt that people love movies for various reasons and have many types to choose from. Some may argue that movies are waste of time. But really, who does not like to escape reality, momentarily, and indulge in the lives, stories, and fantasies of different people? Movies invoke different emotions in people watching the same film. A movie such as Leonardo DiCaprio's *Before the Flood* can serve to awaken, inform, and inspire action to combat a global threat—climate change. Or perhaps lighthearted fun is on the agenda, and then a comedy such as *Meet the Parents* may suffice.

I could elaborate ad-nauseum the many movies I love and their respective genres. There is one particular movie genre (considered a niche genre) that I find fulfilling, suspenseful, dramatic, and hopeful: the "teacher film." What are teacher films or teacher movies? A quick internet search of "teacher movies" produces numerous results such as *Dangerous Minds, Dead Poets Society, Freedom Writers, Lean on Me, Stand and Deliver, The Great Debaters*, and many others. These movies tell many stories related to education. Many times the 'education' may be formal and/or informal. The setting, plot, and characters may vary. However, the basic premise of these movies shows how an 'ordinary' person who has a passion for teaching and helping students can enter a classroom and become a superhero to students. The superhero or "super-teacher" puts on their 'cape' of thick-skin and quickly establishes relationships with the students. As the movies show, there is no shortage of *difficult* student-teacher relationships that need to be established before learning can occur. Many times, the 'super-teacher' may break away from traditional teaching techniques and strategies to grab the students' attention. This is the case in a scene from *Dead Poets Society* where the teacher, John Keating, instructs his students to rip out the introductory pages in their textbooks then proceeds to stand on his desk to embody a way to look at something differently. Through grit, determination, love, compassion, and relentlessness, the 'super-teacher' prevails and all of his or her students make remarkable gains (socially and academically) within one school year.

Growing up in a family full of educators (teachers, principals, deans, administrators, and specialists), I remember at an early age family members sharing stories of their teaching experiences in education. Although I was young, I grew fond of looking forward to Friday nights at my uncle's house where the adults sat around a table and "talked shop." What was it about those stories that caught the ear of an eight- or nine-year-old playing with Legos and sustained his attention? Was it the wonderful Chemistry lessons my uncle created for his students; the peacemaker role my father had to play as the dean of students in the 1970s; or perhaps the student-teaching experiences they had as college students? Of course not, but their stories were like manuscripts that played like mini movies in my mind. So what was so appealing about these conversations? In retrospect, it was the life lessons, tough love, perseverance, conviction, passion, and, most importantly, the love that exuded from their desire to help people—children and young adults particularly. The facilitating and imparting of knowledge to students was a concept that seemed to remain consistent no matter who was sharing stories. Hence, my love for 'teacher films' such as *Lean on Me, Freedom Writers*, *The Great Debaters*, *Dead Poets Society*, and *Stand and Deliver*.

So what does all of this have to do with my unit? When I first entered the classroom, like many other teachers, I thought I was a superhero. Just because I set high and lofty expections, I believed that all of my students would grow in leaps and bounds—within *one* school year. Then reality set in. The "Real life" teaching challenges were a lot harder than what the movies portrayed. As an 8th grade math teacher I experienced students with deficits in math and reading so severe that I questioned how they were able to pass from previous grades.

The reality for me, as many other teachers would honestly confess, is that my movie played more like an episode from HBO's *The Wire* (Season 4). The series, which is set in Baltimore, Maryland, follows the lives of adolescent middle school students in a "fictional" Baltimore public school system in one of the roughest neighborhoods in America. This "story" of socio-economic ills may be more common and applicable to the current state of teaching in urban school districts across the United States. Though not exactly like Baltimore, Richmond, Virginia, still has similar socioeconomic and educational tribulations too. Our school

Still, my superhero cape is not hung up. The stark realities of budget deficits, teacher turnover, neighborhood poverty and violence, and failing schools mean that 'real life' super-teachers will not save the day in 90 minutes. However, through consistency, accountability, support, and high expectations, deficits can be overcome.

Rationale/Background

My passion and reasoning for creating my unit can be traced to two different conversations during my teaching journey. Both were conversations I had with family members who are also teachers—my sister and my cousin. My sister, who was a third grade teacher at the time, floored me during a conversation when she said very casually, "You know, prisons are built on third and fourth grade reading scores." The other conversation was with my cousin (a reading specialist for our district) who explained the difficulties she faces trying to get non-language arts teachers to incorporate reading and writing into their curriculum.

According to the National Assessment of Adult Literacy (NAAL) two-thirds of students who cannot read proficiently by the end of the 4th grade will end up in jail or on welfare[1] . As a new teacher, I remember

worrying about how I could help address this problem from an 8th grade math teacher's viewpoint. All of the students' that I serve are from the inner city of Richmond, VA, and live in households below the poverty level. These students are already several grade levels behind in math and English prior to entering the eighth grade. The NAAL research also shows that 85 percent of all juveniles who interface with the juvenile court system are functionally illiterate[2] I have found this statistic to be plausible over my time teaching, as I often hear stories about former students going in and out of the juvenile system.

About four years before I had that conversation with my cousin, I decided to introduce more writing into my class as a result of attending district-wide and school-wide professional development programs. Our district administrators and specialists stressed the importance of how reading and writing should *not* be restricted to *only* the language arts teachers and their curriculum, but used by all teachers in a cross-curricular approach. I believe that reading and writing strategies can and should be used to improve both mathematics and reading skills. Our math specialist discussed the importance of embedding reading and writing activities and assignments into our math lesson plans. I consulted with a few close friends among the English teachers at my school to figure out how to proceed with implementing the recommendations I had heard in my professional development. I started out by having my students journal their past experiences (positive and negative) in math class. I allowed them to journal about "good" and "bad" math teachers, content, activities… anything that would get them writing about math. I still do math journaling even though there is always resistance because the students do not want to "read or write" in *math* class! I am very patient with this process because I remember feeling the same way the students do when *I* was taking the necessary tests and courses to qualify for a teaching license.

I remember struggling with only one particular test when I switched careers into education—the *Reading for Virginia Educators: Elementary and Special Education* (RVE). This is the test required to teach special education or elementary school in Virginia. I failed the RVE twice and remember thinking, "I'm not a reading teacher, *all* I want to do is teach math." I eventually sought the help of my coworker and my cousin. I passed the test, but at the time I could not understand why secondary special education teachers not teaching reading *had* to take the RVE exam. However, I recalled the conversation with my cousin and the light bulb turned on. I started to realize the importance of requiring all core special education teachers to know how to teach literacy development. It made perfect sense that reading strategies should be understood and taught in all core content areas, *especially* math. I was also thinking that all teachers, regardless of whether they are special education or elementary, should be able to help students with reading and writing strategies. As we were talking, I was recounting all the times that my students were able to solve problems with rote algorithms, but then struggled tremendously when presented with a word problem.

Some say math is a language. If this is true, then teaching strategies for solving math word problems is comparable to teaching two languages—math and English—in one setting. What are a teacher, and student, to do if they are not proficient in the English language *and* math? I sought help from veteran teachers about strategies they used when teaching word problems. Some teachers admitted that they avoided word problems because of the grave deficits in reading and lack of basic math skills. I have decided that this is exactly the wrong thing to do. This is running from the problem. Some teachers recommended shortcuts to ease the pain for students solving word problems by highlighting or boxing key information, but that strategy does not address the reading comprehension issues. The frustration of time constraints for teaching certain objectives also prevents them from covering word problems more in-depth.

This unit will focus *solely* on developing one-step (addition/subtraction) mathematical word problems for struggling readers at the lowest reading levels. This foundation will allow me to build the confidence and

ability of struggling readers. The future goal, which I will assess as the year progresses, is to have students solve more complicated math word problems with increased reading complexities. Many word problems can be solved without writing any equations, and this approach will be encouraged throughout this unit. Helping students solve some these problems before introducing variables and equations can make that task easier. There will be additional resources and references in the appendix that have proven valuable. A long term goal that I will implement is to eventually have a second phase where the mathematical structure gets more difficult. The end goal is for students who struggle with literacy deficits to increase their ability to read, fully comprehend the word problem, and correctly solve the problem.

Struggling Readers in The Math Classroom

Deficits and Disabilities in the Special Education Math Classroom

By law, American public schools have to provide specific types of resources and accommodations for children with disabilities. The Individuals with Disabilities Education Act (IDEA) states that a "child with a disability" means a child:

> with intellectual disabilities, hearing impairments (including deafness), speech or language impairments, visual impairments (including blindness), serious emotional disturbance (referred to in this chapter as "emotional disturbance"), orthopedic impairments, autism, traumatic brain injury, other health impairments, or specific learning disabilities[3] .

Whether you are a licensed Special Education teacher or a General Education teacher, Individualized Education Plans (IEP) and 504 plans should be very familiar. The IEPs and 504 plans provide pertinent information, especially to the use of word problems in the mathematics classroom. Careful and strategic planning should be devoted to instruction, assignments, and activities in the special education and co-taught classrooms. Many times teachers are faced with designing lesson plans with students who have reading and math disabilities in mind. It presents a challenge, but that is a task for the Special Education teacher to figure out.

As with other school districts, Richmond is guided by pacing charts that suggest the amount of time a teacher *should* spend on certain objectives. Of course, there is *hardly* enough time to cover what you want to address. Many urban school districts have transient populations, attendance problems, behavioral issues, and lack of parental involvement or parental accountability for students with disabilities. These issues are a recipe for constantly playing make-up or 'fix-up,' which is essentially covering just enough material to move on to the next objective. In the long run, the students are the major stakeholders who lose. We are not doing them any justice. I developed this unit for those students. The math word problem sets in this unit should be easily adaptable in the special education daily routine as a warm-up, exit ticket, or remediation exercise.

Deficits in the General Education setting with Word Problems

My experiences in the general education and special education classrooms have afforded me unique perspectives on student personalities: strengths and weakness, motivation, effective/ineffective strategies—to

name a few relevant traits. The deficits in the students with IEPs and without IEPs in the co-taught general education classroom are sometimes similar. It is not uncommon to have 'general education' students with deficits comparable or sometimes even worse than some of their peers with IEPs. Why is this? Students who "fly under the radar" or go unnoticed can, over time, develop deficiencies in math and reading. I want this unit to be a valuable resource to help them. Again, the math word problem sets can be easily adaptable in the co-taught setting as a warm-up, exit ticket, or remediation exercise.

Review of Reading Strategies for Solving Math Word Problems

Different content teachers use different types of strategies applicable to their specific content. There is no right or wrong strategy that a teacher has to use in their given content. Math is no different. An internet search of "teaching strategies" provides an abundance of suggestions. Nonetheless, this section will focus on research based strategies for solving math word problems. These are options that can be used in the unit and/or everyday teaching in the math classroom.

An article entitled *Reading Coaching for Math Word Problems* presents some meaningful strategies and viewpoints for reading comprehension in math word problems and the role of literacy/math coaches. The article is from The Literacy Coaching Clearinghouse, which is a website that "offers an array of policy and practice briefs and coaching tools for literacy coaches, teachers, administrators, and researchers". In the article, the three authors Sharon A. Edwards, Robert W. Maloy, and Gordon Anderson draw from their collective experiences teaching and working on the elementary and collegiate level, as well as the computer science field. They used the fourth grade questions from the Massachusetts Comprehensive Assessment System (MCAS) test to identify seven specific word and math language comprehension challenges[4] . The seven strategies they discuss are as follow:

1. Unfamiliar Vocabulary
2. Proper Names
3. Sentence Structure and Syntax
4. Math Terminology
5. Multiple Math Operations
6. Words and Numbers
7. Visual Displays of Information

The Seven Strategies

1: Unfamiliar Vocabulary

The authors discuss the challenges for students to solve math word problems because of unfamiliar vocabulary. They give examples of different words on the MCAS that students may not have experience with, such as "bow" and "depositing." Obviously there are many more words that students are not familiar with on this state exam, as well as any other state exam across the country. This is a common problem shared with all math teachers regardless of their location. They use a word problem (below) from MCAS to provide some strategies.

> *Haley swam 22 laps each day for 18 days. Then she swam 25 laps each day for 10 days What was the total number of laps she swam over the 28 days?(Massachusetts Department of Education, 2006)*

They suggest ignoring the words in the problems that are not familiar and those that are confusing to students. In the Haley question, a youngster can read the problem while ignoring the words *swam* and *laps*. The reader can learn to recognize that Haley did something 22 times each of 18 days and then 25 times each of 10 days. Multiplying 22 x 18 and 25 x 10 and then adding those two totals will produce a correct solution without the student needing to understand what it was that Haley did[5] .

2: Proper Names

The article states that there were 29 proper names in 39 questions. As a middle school teacher, I took the strategy of looking for proper names for granted in my classroom. Because I teach middle school students, I often assumed they would not get confused by proper names. However, this is very noteworthy point because those struggling readers on the middle school level may be on a third or fourth grade reading level. The strategy they suggest using is having students make the names familiar. Replacing the name in the word problem with its first letter, or with their own name or a more meaningful name, could help connect students to the problem.

3: Sentence Structure and Syntax

The article makes another valid point about the way in which tests and textbooks are written. Those texts "are written in compositional, not conversational English." As such, they are not easy for some young readers to interpret. Consider the following problems:

> Mr. Thomas walks every day. The distance that he walks each day is between 4 miles and 8 miles. Which of the following could be the total number of miles Mr. Thomas will walk in 30 days (Massachusetts Department of Education, 2006)

The article suggests using a strategy from a mathematician named George Polya for the aforementioned word problem. Polya created a four step approach to solve word problems. Polya's book "How to Solve It" is a viable resource that identifies a four step method for problem solving: Understand the problem, Devise a plan, carry out the plan, and look back.

> In Polya's framework, a problem solver first understands what type of problem is being posed, then clarifies what is being asked for, investigates the problem to see what information is already given, formulates a plan for solving the problem, and checks the computational work for any missteps or errors before finalizing an answer[6] .

The article points out that Polya's approach addresses math and reading strategies. They also state that the first three steps in Poyla's approach/chart are very reading comprehension specific.

4: Math Terminology

The researchers state that math terminology "is a comprehension as well as decoding challenge." This challenge is further complicated for students with disabilities who struggle with comprehension *and* decoding. Obviously the various "math terms" that represent the different four basic math operations (addition, subtraction, multiplication, and division) are complex for students. In addition, equations, inequalities, and expressions are also problematic for students. Another word problem the authors analyze from the MCAS is:

> Last month, 3801 people ate at Tony's Pizza. This month, 2765 people ate at Tony's Pizza. How many more people ate at Tony's Pizza last month than this month? (Massachusetts Department of Education, 2007)

The strategy they propose may seem obvious, which is to teach math vocabulary. The research proves their point. Their second strategy of having students "create their own informational placements and posters as memory guides to math terminologies and memory guides" can lend itself to more buy-in and ownership because the students are the one's creating the "math vocab."

"How many more" suggests adding to find a total, but "more" in the question above requires subtracting the smaller number from the larger to find the correct answer. I feel that understanding of issues like this is best achieved by class discussions involving reading and interpretation of word problems, and these discussions will be an important feature of my unit.

5: Multiple Math Operations

Word problems and math problems in general that require the use of multiple steps to solve can pose challenges. The authors refer back to the "Haley Swimming problem" to make their point and offer strategies for dealing with multiple math operations:

> Haley swam 22 laps each day for 18 days. Then she swam 25 laps each day for 10 days what was the total number of laps she swam over the 28 days?(Massachusetts Department of Education, 2006)

As they point out, the mistake that many students will make is to add throughout the problem instead of multiplying then adding. The tendency for some students may be to add the 22 laps + 18 days + 25 laps + 10 days and believe the sum is their answer, as opposed to adding the two products from (22 x 18) and (25 x 10).

A possible strategy that is stated for this type of problem is to have students change the "context" of the problem, without changing the numbers. For example, they state that instead of "Haley" (or any person) swimming laps it could "Haley" shooting basketballs at a goal. The basketball fans in the class will relate to the idea of making 22 baskets for 18 days followed by making 25 baskets for 10 days more easily than swimming laps. In this way, those children will recognize that more than one math operation is needed to answer the problem[7] .

6: Words and Numbers

In math word problems that combine words and numbers, the article states that the blending of words and numbers is problematic. The following example is used to demonstrate the challenges:

> Mr. Jordon is buying 3 CDs. Each CD costs $18.99 including tax. Which is the best estimate of the cost of the 3 CDs?" (Massachusetts Department of Education, 2001)

It is observed that the numbers 3 and $18.99 are embedded within sentences that appear straightforward, yet the two words *including tax* are easily missed[8] .

Their strategy for dealing with this is to have students "compose their own math word problems, math comics, and math stories as another way to understand how writers blend words and numbers together to pose questions[9] .

7: Visual Displays of Information

Even though a picture may be worth a thousand words *visual displays* may actually present challenges for students. To read and interpret charts, graphs, pictures, and other visual displays of information. These visual displays can be confusing even to adult readers (Tufte, 2001)[10] . The confusions, as the authors point out, can be from an inability to correctly interpret words and numbers not in a "normal" sentence, but spread throughout the visual graphic designs. The authors' strategies are straightforward—design visual displays that have meaning and ownership to the students. By creating stimulating visual displays (charts, tables, graphs) that peak students' interest and/or curiosity, it may lead to them discussing their displays with friends and family.

The article concludes with a very important point—"Math word problems have been a relatively understudied component of math and literacy learning (Powell, Fuchs, Fuchs, Cirino & Fletcher, 2009)[11] . I found this research helpful in designing certain aspects of this unit, and overall a great resource. I also applaud the recommendation of having literacy coaches use more math word problems to help address deficits in reading and math. Literacy coaches and teachers need wide-ranging strategies in order to support children as they improve their skills in reading and mathematics[12] . My experience with math coaches has been that they focus primarily on math procedures and computation aspects, and much less on the literacy aspects of math (e.g. comprehension, decoding, and fluency) in math word problems.

Structure of Word Problems

Understanding How to Create Multi-step Word Problems

In order to help struggling readers build math understanding through word problems, a basic understanding of *how* word problems are constructed is a must. During the Yale National Teacher Initiative seminar ("From Arithmetic to Algebra: Variables, Word Problems, Fractions and the Rules") a great amount of time was dedicated to understanding the classification and construction of word problems. All teachers in the seminar

started learning the structure of word problems by discussing and solving simple one-step addition/subtraction and multiplication/division problems. We practiced solving and sharing strategies for various one-step word problems both arithmetically and algebraically. This exercise was very helpful because it afforded everyone in the seminar an opportunity to understand how other teachers and their students solved certain word problems. Because it was a mixture of elementary and secondary teachers, I gained a great deal of insight for this unit and future strategies. For example, the elementary teachers shared how their students were able to use pictorial representations and/or the Singapore Bar method to solve word problems. Eventually, with much practice and understanding of one-step taxonomies, we built on that knowledge to create two- and three-step word problems.

The word problems constructed for this unit (and for future word problems I create) will use the taxonomies from the Common Core Mathematics Standards. The charts created below were adapted from the Common Core Math Taxonomies (Table 1 and Table 2). Hyperlinks to the full taxonomies for all four operations can be found in the Appendix. These taxonomies serve as a guide for understanding and constructing addition/subtraction and multiplication/division word problems.

Addition/Subtraction

The addition/subtraction word problems have three main categories: Change, Compare, and Part-Part-Whole. The multiplication/division word problems categories are: equal groups, arrays/area, and compare.

There are a total of 14 types of one-step addition/subtraction word problems. The one-step addition/subtraction word problems involving a 'Change' (add to; take from) has 6 different types of problems. The Change problems may also be referred to as "Change Plus" (adding to) or "Change Minus (taking from). An example of the 'Change' matrix is below:

		Unknown Result Unknown	Change Unknown	Start Unknown
Types	Change Plus (add to)	3 + 4 = ?	3 + ? = 7	? + 4 = 7
	Change Minus (take from)	7 – 3 = ?	7 - ? = 4	? – 3 = 4

An example of the six types of 'Change' problems would be:

Change (plus): result unknown, change unknown, or start unknown (3 types of problems)

Change (minus): result unknown, change unknown, or start unknown (3 types of problems)

In addition, the 'Compare' word problems also has 6 different types of problems. The 'Compare' problems may be referred to as "Compare More" or "Compare Less." An example of the 'Compare' matrix is below:

		Unknown Difference Unknown	Greater (Larger) Unknown	Fewer (Smaller) Unknown
Types	Compare More	3 + ? = 7	3 + 4 = ?	? + 4 = 7
	Compare Less	7 – 3 = 4	4 + 3 = ?	7 – 4 = ?

An example of the six types of 'Compare' problems would be:

Compare (more): Difference unknown, Greater unknown, or Fewer unknown (3 types of problems)

Compare (less): Difference unknown, Greater unknown, or Fewer unknown (3 types of problems)

The third category for addition/subtraction is 'Part-Part-Whole' which has 2 different types of word problems. The 'Part-Part-Whole' may also be referred to as "Put together/Take Apart." Under this category word problems either have a total unknown, or addend unknown. An example of the "Part-Part-Whole" matrix is below:

	Unknown	
	Total Unknown	Addend Unknown
Type Part-Part-Whole	4 + 3 = ?	4 + ? = 7 7 – 4 = ?

An example of the two types of 'Part-Part-Whole' problems would be:

Part-Part-Whole: Total unknown or Addend unknown (2 types of problems)

Multiplication/Division

The multiplication/division word problems have three main types: Equal Groups, Arrays/Area, and Compare. Each type of multiplication/division problems has three different categories: Unknown Product, Group Size Unknown, or Number of Groups Unknown.

	Unknown Product	Group Size Unknown	Number of Groups Unknown
	2 x 5 = ?	2 x ? = 10 and 10 ÷ 2 = ?	? x 5 = 10 and 10 ÷ 5 = ?
Equal Groups			
Arrays/Area			
Compare			

Constructing Word Problems

Word Problem Examples

The success of this unit depends on relevant and meaningful word problems. I have created 14 one-step word problems for addition/subtraction and 9 one-step multiplication/division word problems at the remedial (Tier 3). I also created some two-step word problems with increased reading complexities that can be used as guide for higher level students. All word problems can be found in the Appendix.

Differentiation

Carol Ann Tomlinson, whom many consider the guru of differentiation, states that differentiation is tailoring instruction to meet individual needs. Whether teachers differentiate content, process, products, or the learning environment, the use of ongoing assessment and flexible groups makes this a successful approach to instruction[13] .

In short, differentiation is a response to learner's needs." This unit is a direct response to students who struggle in reading within the mathematics setting. The reading and math deficits are profound within the

special education and general education setting. This unit will use one-step addition/subtraction problems that meet learners on a lower reading. Because our district (Richmond Public Schools) encourages the use of 'Tier levels,' I will use one-step addition/subtraction word problems on a Tier 3 reading level.

Tier levels

For me, Tier levels or 'tiered' instruction is still a response or adjustment in my instruction and activities that continually meet the needs of my students. In this unit all of my students to start on the Tier 3 level for solving one-step addition/subtraction word problems. These word problems will be very direct and straightforward. The word problems will have very few vocabularies, decoding, or comprehension issues that students would find too challenging or discouraging from answering. The goal is for students to understand and explain how they would solve the problem.

Teaching Strategies

The teaching strategies that I will use for this unit are Whole Group and Small Group Instruction, Think-Pair-Share, and Choral Reading. Learning styles inventories are an important resource that I use to identify the types of learners that are in the classroom. The learning styles inventory will support the

Whole Group/Small Group

Because this unit is focused on the reading *and* math abilities of students, it is crucial for me to able to assess the reading needs of each student through whole group instruction as well as small group discussion. Before any learning is done, I will set the tone of respect, confidence, trust, and openness for the classroom. I take a firm stance in letting the students know that I have their best interest ("I got their backs") if they make mistakes, and I will not allow other students to make fun of them. This is crucial because as an eighth-grade student with pride and ego, it can be difficult to address *reading* in a *math* classroom. I often share my experience as a shy and reserved student who was nervous to read in class because of the fear of making a mistake. I also share how some of my previous students could not read as well as other students but continued to practice because they wanted to get better and they knew I would not let other students tease them. I ended those stories and experiences by telling the students that part of the classroom rules and norms is to show respect to their peers when *trying* something new and to embrace 'failure' as part of the process of learning. We will share stories of how everyone learns from failures (or mistakes)—touching a hot stove, learning from a 'failed' friendship, etc.

After the expectations are explained for classroom norms, I will explain that throughout the year we will be strengthening reading abilities while working on word problems. During whole group instruction, students will be asked to recall prior knowledge from their experiences in sixth and seventh grade with solving equations. It has been my experience that students will give explicit examples such x+3=7 or 2x=8 as evidence that they remember what an equation 'looks like.' Rarely, if ever, have they given a one- or two-step word problem as an example. The student responses will serve as segue to reassure the students that word problems can be solved with equations, like those they mentioned, or without writing down equations then solving them. The objective for the day and the forthcoming weeks, which is to strengthen reading abilities while solving word problems, will be written down in place that students can see and refer to.

I anticipate several ‘sighs’ because most students tend to avoid word problems because they say ‘it is too much reading.’ I will prompt them for feedback as to why they do not enjoy word problems: Is the reading difficult? Is the math too hard? Are word problems too long? Did your previous math teachers ever cover word problems? I read several different one-step and two-step word problems. I will also model how the students can ‘solve’ the word problems arithmetically and algebraically.

Think-Pair-Share

Students need many opportunities to talk in a linguistically rich environment. Researchers have found that students' learning is enhanced when they have many opportunities to elaborate on ideas through talk[14] .

In sharing their ideas, students take ownership of their learning and negotiate meanings rather than rely solely on the teacher's authority[15] .

The Think-Pair-Share strategy will be important for strengthening reading abilities as well as sharing problem solving techniques. After whole group instruction, students will be told to form groups of no more than three with their “shoulder partner” (or closet seated student). Students will initially be given the same one-step addition/subtraction word problems at the Tier 3 reading level. The processes for this strategy is to have students individually take a moment to read and think about the word problem then determine how they would solve it. Students will select someone to discuss with the class what the problem is asking for, how they solved it, and if there was anything (vocabulary, expressions, etc.) that was unclear in the word problems. This is a great opportunity for the students and teacher to learn from their feedback. Because this unit serves as a foundation for building and strengthening reading skills focusing solely on one-step addition/subtraction word problems, students will visit higher reading level one- and two-step addition/subtraction word problems as their abilities progress throughout the school year. Some examples one-step and two-step word problems at higher reading Tier levels (Tier 1 and 2) can be found in the Appendix.

Choral Reading

Through repeated readings of the text, the reader increases sight word vocabulary and ability to decode words quickly and accurately. This fluent reading enables the reader to spend less time on decoding and have greater comprehension of the text[16] .

The choral reading strategy is based on having students read aloud, in unison, the same text (word problems) with me (the teacher). In a typical reading classroom, students would ‘choral read’ information from a classroom text or novel out loud so that everyone is following and reading along. For this unit, in the mathematics classroom, students will read one-step word problems in unison to strengthen their fluency and comprehension. Questions will be asked to ensure students comprehend what they read. I will model how to read and also highlight strategies for what to do when I get to unfamiliar vocabulary and/or information. Again, for this unit I will focus on strengthening the fluency and comprehension through the one-step addition/subtraction word problems. If students continue to struggle, I will pull those students into a small group to continue practicing. Those students that show strengths in reading fluency and comprehension will solve one-step addition/subtraction word problems at a higher level (Tier 1 or 2). As the year progresses, it is my hope and goal that the students reading and math abilities progress. To accommodate for their progression, I will tailor the type of word problem (one-, two-, or three-step) with the applicable reading grade level.

Classroom Activities

The problems in this unit will be used three different ways: Short activity before classroom instruction begins called the “Snapshot” (or Warm-up); The “Exit Ticket” (or Wrap-up) at the end of class; and as remediation during remediation block or one-to-one tutoring.

Snapshot (Warm-Up)

The Snapshot (or Warm-Up) is usually completed within the first 10-15 minutes into class. In previous school years I have used the Snapshot as a way to review previously taught objectives covered throughout different marking periods. I would also include one or two *new* problems/concepts that have yet to be covered to determine students’ ability and familiarity.

Because I have to constantly review previously taught information, the problems in this unit will be given once or twice throughout the school week for the majority of the school year (my thinking is to stay consistent in small measures). The hope is that because these problems start on a basic (below) grade level, students will think the unit problems are ‘easier’ than the ‘normal’ 8th grade snapshot problems. It is also my intention that once the reading deficits in the one-step addition/subtraction improve we will move to one-step multiplication/division word problems. As I constantly assess and reassess students throughout the year where they are, I will (hopefully) build on the one-step word problems to and use two-step word problems to strengthen reading skills.

After a few weeks of getting to know the students and their capabilities, students will respond to their given Tier level one-step addition/subtraction word problems using white boards, composition books (which only has snapshot problems), or verbally. I will allow students to respond based their preference. However, there will be times when I encourage certain students, based on their abilities, to respond a certain way in order to push them and assess their growth with vocabulary, fluency, comprehension, etc.

Exit Ticket

The Exit Ticket (or Wrap-Up) will be performed within the last 10-15 minutes of class as a way to check for understanding. The format for the Exit Ticket will be performed the same as the Snapshot. Students will have three different ways to respond: verbally, white boards, or ‘exit slips’ (index card showing how they solved the problem).

Remediation/Enrichment

Because I am able to dictate how I structure my remediation efforts, I will remediate in one or two ways: small groups (no more than 3 students) or individually (one-to-one). Based on students’ performance with reading *and* solving one-step word problems I will determine which group of students or student that needs extra help. In addition, I will also provide an opportunity for students that have decent reading abilities the opportunity to strengthen them outside of the regularly scheduled classroom time.

Appendix

Implementing District Standards

Virginia is a not a Common Core State. We follow standards set by the state called the Virginia Standards of Learning (SOLs). This unit was, in part, derived from an eighth grade standard that our district uses which is aligned to the SOL objective 8.15a-c which states that students will: .

1. a) Solve multi-step linear equations in one variable on one and two sides of the equation.
2. b) Solve two-step linear inequalities and graph the results on a number line.
3. c) Identify properties of operations used to solve an equation.

Taxonomies

The hyperlinks to the Common Core Math Taxonomies are listed below:

Addition/Subtraction: http://www.corestandards.org/Math/Content/mathematics-glossary/Table-1/

Multiplication/Division: http://www.corestandards.org/Math/Content/mathematics-glossary/Table-2/

Word Problems

One-Step Addition & Subtraction Problems (Tier 3 Reading Levels)

Examples of Change Plus (aka add to) & Change Minus (aka Take from) problems:

1. Alaysia had 3 blue fidget spinners. On her birthday, Alaysia received 4 more blue fidget spinners. How many blue spinners does Alaysia have? (Change Plus; Result unknown) [3+4=?]
2. Alaysia had 6 blue fidget spinners. She gave 2 spinners to her brother because he did not have any. How many blue spinners does Alaysia have left? (Change Minus; Result Unknown) [6-2=?]
3. Alaysia had 3 blue fidget spinners. She got some more blue spinners for making the honor roll. Then Alaysia had 7 blue spinners. How many blue spinners did Alaysia get for making the honor roll? (Change Plus; Change Unknown) [3+?=7]
4. Alaysia had 6 blue fidget spinners. She had 4 blue spinners left after giving her brother some blue spinners. How many blue spinners did Alaysia give her brother? (Change Minus; Change Unknown) [6-?=4]
5. Alaysia had some blue fidget spinners. She got 3 blue fidget spinners for her birthday. Then Alaysia had 7 blue fidget spinners. How many blue fidget spinners did she have before her birthday? (Change Plus; Start Unknown) [?+3=7]
6. Alaysia had some blue fidget spinners. She gave 2 blue spinners to her brother. After that she had 4. How many blue spinners did Alaysia have before? (Change Minus; Start Unknown) [?-2=4]

Examples of Compare More & Compare Less problems:

1. Alaysia has 4 blue fidget spinners. Her brother, Malik, has 7 blue spinners. How many more blue spinners does Malik have than Alaysia? (Compare More; Difference Unknown) [4+?=7]
2. Alaysia has 4 blue fidget spinners. Malik has 7 blue spinners. How many fewer blue spinners does Alaysia have than Malik? (Compare Less; Difference Unknown) [7-4=?]

3. Alaysia has 4 blue fidget spinners. Her brother, Malik, has 3 more blue fidget spinners than Alaysia. How many blue spinners does Malik have? (Compare More; Greater Unknown) [4+3=?]
4. Alaysia has 4 blue fidget spinners. Her brother, Malik, has some blue fidget spinners as well. Alaysia has 3 fewer spinners than Malik has. How many blue spinners does Malik have? (Compare Less; Greater Unknown) [3+4=7]
5. Alaysia has some blue fidget spinners. Her brother, Malik, has 7 blue spinners. He has 3 more blue spinner than Alaysia. How many blue spinners does Alaysia have? (Compare More; Fewer Unknown) [?+3=7]
6. Alaysia has some blue fidget spinners. Her brother, Malik, has 7 blue spinners. Alaysia has 3 fewer blue spinners than her brother. How many blue spinners does Alaysia have? (Compare Less; Fewer Unknown) [7-3=?]

Examples of Part-Part-Whole (Put together) problems:

1. Alaysia has some blue fidget spinners. She keeps them on a shelf in her room and in her school locker. On her shelf she has 3 blue fidget spinners. In her school locker she has 4 blue fidget spinners. How many blue spinners does Alaysia have? (Put together; Whole Unknown) [3+4=?]
2. Alaysia has 7 blue fidget spinners. She keeps them on a shelf in her bedroom and in her school locker. She has 3 blue spinners in her school locker. How many blue spinners are on her bedroom shelf? (Put together; Part Unknown) [3+?=7, 7-3=?]

One-Step Multiplication & Division Problems (Tier 3 Reading Levels)

Examples of Equal Groups

1. Malik's mother has 2 bags filled with 6 apples. How many apples does his mother have in all? (Equal Groups, Unknown Product) [2x6=?]
2. If Malik's mother shares 18 apples equally among her 3 son's, then how many apples will each son receive? (Equal Groups, Group Size Unknown) [3x?=18, and 18÷3=?]
3. If Malik's mother has 18 apples to packed 6 to a bag, then how many bags are needed to pack the apples? (Equal Groups, Number of Groups Unknown) [?x6=18, and 18÷6=?]

Examples of Arrays/Area

1. Malik's mother has a garden in her backyard. There are 2 rows of apples with 6 apples in each row. How many apples does his mother have in the garden? (Arrays/Area, Unknown Product) [2x6=?]
2. If Malik's mother has 18 apples that arranged into 3 equal rows. How many apples are in each row of the garden? (Arrays/Area, Groups Size Unknown) [3x?=18, 18÷3=?]
3. If Malik's mother has 18 apples that are placed into equal rows of 6 apples, then how many rows of apples are there in the garden? (Arrays/Area, Number of Groups Unknown) [?x6=18, and 18÷6=?]

Examples of Compare

1. Malik's Spalding mini-basketball cost $6. He wants a Nike mini-basketball that cost 3 times as much as the Spalding basketball. How much does the Nike mini-basketball cost? (Compare, Unknown Product) [6x3=?]
2. Malik's Nike mini-basketball cost $18 which is 3 times as much as the Spalding mini-basketball. How much does a Spalding min-basketball cost? (Compare, Groups Size Unknown) [3x?=18, 18÷3=?]

3. Malik's Nike mini-basketball cost $18 and a Spalding mini-basketball cost $6. How many times as much does the Nike basketball cost as the Spalding basketball? (Compare, Number of Groups Unknown) [?x6=18, and 18÷6=?]

Annotated Bibliography

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Endnotes

1. National Assessment of Adult Literacy (NAAL). A national representative and continuing assessment of English language literacy skills of American Adults. https://nces.ed.gov/naal/
2. Ibid
3. Individual with Disabilities Education Act (IDEA). https://sites.ed.gov/idea/about-idea/
4. Anderson, G., Edwards, S. A., & Maloy, R. W. (2009). *Reading Coaching for Math Word Problems*.
5. Ibid
6. Ibid, 2

7. Ibid, 3
8. Ibid, 3
9. Ibid,3
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11. Ibid, 3
12. Ibid, 3
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14. Pressley, M. (1992). Beyond direct explanation: Transactional instruction of reading comprehension strategies.
15. Cobb, P., Wood, T., Yackel, E., Nicholls, J., Wheatley, G., Trigatti, B., & Perlwitz, M. (1991).
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